Physical Hazards

Falls

FACE 87-46: Confined Space Fatality at a Wastewater Treatment Plant in Indiana

INTRODUCTION

On June 6, 1987, a maintenance worker for a city's wastewater treatment plant entered the plant's "wet well" to clean the bar screen which filters the raw sewage prior to its entry into the plant. The employee performed this duty without a co-worker or a safety harness. The event was not witnessed. The body was discovered at 12:38 p.m., approximately on hour after the victim was last seen. The victim's body was removed from the "wet well" by the local fire department and pronounced dead at the site by the county coroner.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer in this incident is a small municipality in Indiana with a population of approximately 23,000. The wastewater treatment plant employs 17 persons: seven certified operators (five working at the plant and two working the city's sewers), five maintenance laborers, two laboratory technicians, one process control technician, one maintenance foreman, and one plant superintendent. The plant operates three shifts providing around the clock coverage. Safety issues involving confined space entry were informally communicated to the employees during personnel meetings, occurring every 4 to 6 months. These meetings discussed the importance of:

1. Using a gas detection meter to determine the air's quality.
2. Using a safety harness and rope around the employee entering the space.
3. Positioning a co-worker at the entrance of the space.

Although the meetings reviewed these safety procedures, the procedures were rarely practiced. The only gas detection meter and harness owned by the plant was kept on the sewer maintenance truck and was unavailable for use while the truck was away from the facility. Employees frequently entered the "wet well" alone.

SYNOPSIS OF EVENTS

On June 6, 1987, three employees were scheduled to work: a laboratory technician, an operator, and a laborer (the victim). The victim and the operator arrived at work at the usual starting time for the day shift (8 a.m.); the laboratory technician, who was planning to leave his shift early, arrived at 6 a.m. Shortly after 8 a.m. it was determined that the east primary aeration tank had shut down. In response to this problem an extra laborer and the maintenance foreman were called into work. In order to repair the problem associated with the aeration tank the 14-foot-deep aeration tank had to be drained. this was accomplished by re-routing the sludge from the east aeration tank back to the "wet well" at the entrance of the plant. The "wet well" is the entry point for all industrial, commercial, and residential sewage and is 27 feet long by 18 feet wide by 26 feet deep. Access to the bottom of the well is provided by a permanent ladder which terminates on a concrete walkway at the bottom of the well. The raw sewage enters the well at the flow gate, travels through a trough (24 inches deep), and drains via gravity into a "comminuter." The "comminuter" pulverizes large debris, such as bricks, large rocks, or tree branches that find their way into sewer lines. The "comminuter," which required approximately five major repairs since its installation in 1970, had been shut down since 1984.

Thus, the primary means of preventing large objects from entering the plant was a "bar screen" which needed to be cleaned approximately three times per shift. Workers used a metal rake to scrape off debris collecting on the screen and deposited that debris into a bucket. Upon completion of the job, employees would climb to the top of the ladder, hoist the bucket of debris to the surface, and discard. Re-routing the sludge from the east aeration tank to the "wet well" increased the volume of water flowing into the "wet well" and caused a more pronounced odor (described as "rotten eggs"). Additionally, the "bar screen" clogged more often requiring more frequent cleaning. The victim had cleaned the screen four times during the first 3 hours of his shift. Each time this was performed without sampling the air, without a safety harness attached, and without a co-worker positioned at the entrance. The victim was also to

mow the lawn that morning. A co-worker, who was also mowing the lawn, went to lunch at 11:37 a.m. and last saw the victim cutting grass.

When the co-worker returned from lunch at 12:38 p.m., he noticed that the rope and bucket were in the well. The co-worker walked to the "wet well" and noticed the intake gate was closed, the cleaning rake was lying on the cement platform, and the bucket was empty. He saw the victim's left leg protruding from the surface of the sewage. The rest of the victim's body was submerged in the trough.

The co-worker ran to the office where the laboratory technician was working and told him to call the emergency squad and fire department. The co-worker then returned to the "wet well" with the maintenance laborer and they both descended into the well. While trying to retrieve the body, they became nauseated and faint and exited via the ladder. Upon ascending the ladder one of the workers stated he almost slipped and fell into the well. The ambulance arrived, followed by fire fighters. Using self-contained breathing apparatus (SCBA), two firemen descended into the well. The firemen retrieved the victim and laid him on the cement platform. One of the firemen descended into the well without a breathing apparatus to take pictures. He experienced some light-headedness and eye irritation. The victim was hoisted to the surface and pronounced dead at 1 p.m. by the coroner. The five firemen involved in the incident were all taken to the local emergency room for evaluation of nausea and dizziness. No one required hospitalization; however, three of the five received tetanus shots.

CAUSE OF DEATH

An autopsy was performed by the county coroner. The official report is pending a blood toxicology screen and serum level of anti-epileptic medication. A noncompounded fracture of the victim's left knee at autopsy suggested a fall of at least five feet. The death certificate lists the cause of death to be "aspiration of foreign material."

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should maintain equipment in proper operating condition.

Discussion: This facility recognized the need for an automated procedure to prevent large debris from entering the plant and installed a crushing device called a "comminuter" in 1976. This device, when working, adequately performed the task. Its use eliminated the need for operators and maintenance laborers to enter the "wet well," thus eliminating this hazardous exposure. Eliminating the need to enter a confined space completely abates any hazards associated with the confined space. The "comminuter" should be maintained and repaired in operating condition.

Recommendation #2: The employer should initiate comprehensive policies and procedures for confined space entry.

Discussion: Although the employer had outlined informal procedures for confined space entry prior to the incident, these should be expanded and formalized into a written policy. This policy should include the following points:

1. Is the entry necessary? Can the task be completed from the outside?

2. Has a permit been issued for entry?

3. Has the air quality in the confined space been tested?

   - Oxygen supply at least 19.5%
   - Flammable range less than 10% of the lower flammable limit
   - Absence of toxic air contaminants

4. Has the confined space been isolated/locked out from other systems?

5. Have employees and supervisors been trained in selection and use of personal protective equipment and clothing?

   - Protective clothing
   - Respiratory protection
   - Hard hats
   - Eye protection
   - Gloves
   - Life lines
   - Emergency rescue equipment

6. Have employees been trained for confined space entry?

7. Is ventilation equipment available and/or used?

8. Is the air quality tested when the ventilation system is operating?

Recommendation #3: Employers should enforce safety procedures.

Discussion: Employees of this facility did not routinely follow the established confined space entry procedures. Employers must enforce established procedures and supervisory personnel must continuously monitor work practices.

Recommendation #4: Employees who are required to enter confined spaces should receive pre-placement and periodic physical examinations to determine that they are physically capable of performing these duties.

Discussion: During the course of employment the physical condition of an employee can change and the employee can become inadequately suited to the job's responsibilities. Employees required to enter confined spaces should receive pre-placement and periodic physical examinations to determine that they are physically capable of performing these duties. The victim had a history of epilepsy dating back to his childhood. The victim's last known seizure occurred in 1978 and his last known evaluation was done on February 29, 1984. His seizures were controlled with medication and a physician's note dated January 1984 stated the victim's seizures were under control and he could "resume normal activities." The victim was hired by the wastewater treatment plant in 1976 at the age of 16. At that time he was 5'11" and weighed 210 pounds. He listed his history of epilepsy and stated that he was on medication. At the time of the victim's death co-workers estimated his weight to be 230 pounds.

FACE 87-47: Worker Dies Inside Filtration Tank in Michigan

INTRODUCTION

On May 12, 1987, a city worker died while checking the inside of an empty filtration tank at a sewage treatment plant.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer in this incident is a municipality with a resident population of approximately 160,000. The victim worked at the wastewater treatment plant (in the wastewater treatment department) which has a total of 56 employees, primarily plant operators and plant maintenance personnel. Additionally, there are five lab technicians, three plant foremen, a chemist, a civil engineer, office personnel, and a plant supervisor.

New employees are given a half-day orientation concerning the operating policy of the city. Time off is provided for mandatory reading of safety booklets. All employees are given formal training in hazardous communication, material safety data sheets/"right to know," and the use of self-contained breathing apparatus. Continual on-the-job task training also addresses various hazards encountered on a day-to-day basis. Workplace safety is stressed as a responsibility of each employee. A wastewater treatment plant safety committee which consists of the plant superintendent, two union stewards (a plant maintenance worker and a plant operator), a maintenance foreman, and the civil engineer meets monthly. Accident reports, safety equipment, safety complaints from employees, the implementation of safety directives from management, etc. are discussed at these committee meetings. The two union stewards are given additional time to evaluate employee complaints and safety concerns in the plant. No training is given on confined space entry; however, plant supervisor has necessary testing equipment available to test a confined space atmosphere for oxygen (O_2), hydrogen sulfide (H_2S), and explosive gases. The plant also has several self contained breathing apparatus (SCBA) throughout the plant facility.

SYNOPSIS OF EVENTS

A 55-year-old wastewater treatment plant operator (the victim) with 25 years of experience was inspecting 1 of 12 open-top concrete filter tanks (used for tertiary wastewater treatment) when this incident occurred. Each filter tank is 15 feet wide by 24 feet long by 12 feet deep and is divided vertically in the middle by a concrete baffle. The bottom of each tank contains a filter bed (several feet of filter media composed of graduated sized stone, covered by approximately 12 inches of wheat-sized anthracite coal). Four trough-like weirs spaced equally apart span the width of each tank half, 3 feet above the top of the filter media. A concrete walkway with steel safety rails is located around the top of each tank. Each tank operates with approximately 9 feet of wastewater and is backwashed three times per day. During this process, a small amount of the filter media (i.e. coal) is washed away. In order to determine the amount of filter media lost, the victim (or other plant operators, when assigned) periodically drain each tank and measure the depth of the filter media. To do this employees are required to lower an aluminum ladder into the tank, positioning the feet of the ladder inside a weir, climb into the tank with a steel tape, measure the depth of the filter media, climb back out, and place the filter tank back in operation. This process is repeated for all the filter tanks. The victim had been assigned to inspect the depth of the filter media in all of the filter tanks (a task which he had done at least twice before). Four days prior to the day of the accident the victim had inspected six tanks. The acting plant foreman (the victim's supervisor) was not aware of the victim having experienced any ill effects from these tank inspections.

On May 12, 1987, the victim reported to work at 8 a.m. and was asked by the plant foreman if he required any assistance in the completion of the remaining six tank inspections. The victim said "no" and completed the inspection of one tank and, although there were no eye witnesses, it is presumed that he was in the process of climbing either into or out of a second tank when he fell from the ladder into the weir. The victim struck his head on a ladder rung or on an edge of the weir.

At approximately 10:55 a.m. the victim's supervisor noticed that the filter tank being inspected had no filter tank valve changes documented on the computer for several minutes. The supervisor left the control room and entered the tertiary filter tank building to check on the victim. The supervisor found the victim lying unconscious inside a weir at the bottom of the tank. The supervisor immediately notified office personnel in the plant, who notified the city fire department emergency rescue squad and then summoned a maintenance worker for help. The supervisor and the maintenance worker entered the filter tank, but did not attempt cardiopulmonary resuscitation (CPR). The rescue squad arrived on the scene approximately 2 1/2 minutes after being called, entered the tank, hoisted the victim out, and began to administer CPR. Resuscitation efforts were unsuccessful. The county medical examiner arrived on the scene at about 1 p.m. and pronounced the victim dead at the scene.

CAUSE OF DEATH

An autopsy was conducted and the cause of death listed by the medical examiner was hypertensive and arteriosclerotic heart disease. Also, according to the medical examiner: "Advanced emphysema of the lungs may have contributed to the death. The deceased was considerably overweight...", the " .....laceration of the left side of the head was sustained as the result of the terminal fall." "Yellow discoloration of the skull may have been related to diabetes mellitus."

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Workers who are required to enter confined spaces to perform tasks as part of their job responsibilities should receive pre-placement and periodic physical examinations to determine that they are physically capable of performing these duties.

Discussion: Simply entering and exiting the filter bed placed a great deal of stress on the victim's cardiopulmonary system. Because of pre-existing medical problems (emphysema, arteriosclerotic heart disease, obesity, and diabetes), which were apparently unknown to the victim, he was unable to withstand this stress. This fatality underscores the advisability of pre-placement and periodic physical examinations for any strenuous work, especially in a confined space.

Recommendation #2: The employer should develop a written comprehensive safety program that clearly documents procedures for safe entry into confined spaces.

Discussion: All employees who work in or around confined spaces (wastewater treatment plant employees) should be aware of potential hazards, possible emergencies, and specific procedures to be followed prior to entering a confined space. These procedures should include, but not be limited to:

1. Air quality testing to determine adequate O_2 level.
2. Ventilation of the space to remove air contaminants.
3. Monitoring of the space to determine a safe oxygen level is maintained.
4. Employee's training in confined space entry, testing, and use of personal protective equipment (respirators, clothing, etc.).
5. Standby person outside the confined space for communication and visual monitoring.
6. Emergency rescue procedures.

Even though there were no dangerous air contaminants in the confined space and normal oxygen levels were found in air samples taken inside the filter tank by the DSR research industrial hygienist at the time of the on-site evaluation, entry into confined spaces should not be attempted until atmospheric testing of the confined space ensures that the atmosphere is safe. This testing requirement applies to all confined spaces, including the inside of open-top tertiary filter tanks. Testing must be done by a qualified person

prior to entry. Specific recommendations regarding safe work practices in confined spaces can be found in the NIOSH Publication No, 80-106, "Working in Confined Spaces." This publication also defines and provides recommendations of hot work, isolation, purging, ventilation, communication, entry and rescue, training, posting, safety equipment, clothing, etc.

Recommendation #3: A trained standby person should remain outside of the confined space when a worker enters or works inside. The standby person should visually monitor the tasks being performed inside and should be able to communicate with the worker(s) inside the confined space.

Discussion: A person trained in emergency rescue procedures, assigned to remain on the outside of the confined space for communication and visual monitoring of the person inside is of utmost importance.

Recommendation #4: Employees should be trained in cardiopulmonary resuscitation (CPR).

Discussion: CPR should begin as soon as possible, minimally within 4 minutes (in accordance with American Heart Association guidelines) in order to achieve the best results. To meet this criteria for successful resuscitation, workers should be trained in CPR to support the victim's circulation and ventilation until trained medical personnel arrive. While some employees had apparently received CPR training in the past, employees who arrived at the scene of the accident (prior to the arrival of emergency medical personnel) did not begin CPR on the victim. Retraining in CPR is necessary, usually on an annual basis.

Recommendation #5: The procedure used to measure the level of filter media present in a tank should be evaluated to determine if the procedure could be modified to eliminate the need to enter the confined space.

Discussion: Prior to entry into a confined space one of the first questions that needs to be addressed is whether entry is necessary. The procedure used to measure the level of filter media present in a tank should be evaluated to determine if it could be modified to eliminate the need for entry into the tank.

FACE 88-14: Labor Foreman Falls to His Death Inside Municipal Water Tank in Indiana

INTRODUCTION

On March 21, 1988, a 28-year-old male labor foreman died when he fell 50 feet inside a 700,000-gallon municipal water tank.

OVERVIEW OF EMPLOYER'S SAFETY PROGRAM

The employer in this incident is a multistate corporation specializing in cathodic protection systems which provide a form of protection against electrolytic corrosion. Of the company's 250 employees, 16 perform the same type of work as the victim. The company has a written safety policy which prescribes the use of fall protection where there is potential that a worker may fall in excess of 10 feet. This policy also calls for testing the atmosphere prior to entering any confined space, and for the use of a lifeline, safety harness, and appropriate respirator when working inside a confined space. The victim was employed as a tank department foreman and served as a supervisor at various sites where work on cathodic protection systems for water tanks was being performed.

SYNOPSIS OF EVENTS

The victim and a co-worker were assigned routine maintenance work on the cathodic protection system within an elevated municipal water tank. Approximately 2 months prior to this incident, the tank developed a leak and was drained. A small amount of water remained in the tank at a level below the riser which serves as the tank drain. There was ice on the surface of the water.

The cylindrical tank is approximately 40 feet wide by 60 feet high. A ladder on one of the legs supporting the tank provides access from the ground to a catwalk on the tank. The catwalk circles the tank approximately 125 feet above the ground. A second permanently-mounted ladder extends from the catwalk to the top of the tank. At the top of the tank, a 2-foot-square door provides entry to the tank.

On the day of the incident, the victim and his co-worker arrived at the job site at 11 a.m. Prior to climbing the tank, they noticed an entry hatch on the side of the tank bowl at the level of the catwalk. They decided not to use this entry hatch because they weren't sure they could properly seal it at the conclusion of the work.

At approximately 12:15 p.m., the two men climbed to the top of the tank and found the entry door locked. The men descended the tank, obtained a key from city officials, climbed again to the top of the tank, and opened the door. They suspended a rope ladder through the door to provide access to the tank floor.

The maintenance work on the cathodic protection system required that they replace a fitting which was below the level of the water in the tank. The victim used a section of garden hose to begin syphoning the water from the bottom of the tank and routing it down the wet riser at the center of the tank bowl. Because the water would not be removed by the end of their shift, they performed other necessary maintenance work, planning to return the following day to finish the job.

At approximately 5:10 p.m., the co-worker exited the tank and stopped on the catwalk to wait for his supervisor. When the supervisor did not follow after 4 to 5 minutes, the co-worker climbed to the top of the tank in search of him. The co-worker saw the supervisor inside the tank approximately one quarter of the way up the ladder. The supervisor stated that he was tired and that his arms were numb. The supervisor then continued to climb the ladder.

The co-worker noticed that the supervisor "was climbing wrong and had a funny look on his face." (The supervisor was facing the ladder, as opposed to the standard procedure for climbing a rope ladder from the side thereby producing less swaying motion.) The co-worker asked the supervisor if he needed help. Upon receiving a positive response, the co-worker descended the ladder to assist him. The co-worker managed to grasp the supervisor's hand, however the supervisor was unresponsive to the co-worker's

repeated calls to grasp the ladder. The co-worker was unable to retain his grip, and the supervisor slipped from the ladder and fell approximately 50 feet to the bottom of the tank. The co-worker descended the ladder to aid the victim and moved him slightly from the facedown position near the water where he landed. He returned to the top of the tank where he cried out for help. He got the attention of several individuals located at a business establishment across the street who, in turn, summoned help.

The local fire department received the report of the accident via telephone at 5:15 p.m. and were on the scene at 5:19 p.m. Two fire fighters and an EMT from the local ambulance company entered the tank through the manway located at the catwalk. The victim was found to be bleeding from the mouth and nose, with noticeable deformation of his forearm and right upper leg. No vital signs were detected. The victim was secured to a back board and lowered to the ground. The ambulance departed the scene at 5:54 p.m. and arrived at the local medical center at 6 p.m. where the victim was pronounced dead shortly after arrival.

Neither the co-worker nor the responding rescue personnel noted any unusual odors in the tank, nor did they experience any symptoms indicative of possible oxygen deficiency.

CAUSE OF DEATH

The medical Examiner gave the cause of death as a skull fracture and lacerations of the brain, along with contusions to the lungs.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should periodically re-evaluate company confined space work procedures to ensure that the following areas are addressed:

- ***atmospheric testing is performed prior to entry***
- ***safe climbing devices are employed where needed***
- ***safety harness and lifeline are used in all cases (for rescue as well as fall protection when working at elevations)***
- ***an observer outside of the confined space is available to summon help if needed***
- ***communication devices are available to ensure adequate communications between workers in confined spaces and those outside.***

Discussion: The company that employed this foreman has written safety procedures that require the testing of the atmosphere of any confined space prior to entry. In addition, the procedures specify that a lifeline and safety harness are to be worn while working in a confined space, and that an appropriate respirator be worn when indicated by the atmospheric testing. None of these procedures was followed in this case, nor was any provision made for the use of safe climbing devices. In addition no observer was present, nor was any means provided for communication between the tower and anyone on the ground. If an oxygen deficient atmosphere existed within the tank, it could have proved fatal to both workers.

Recommendation #2: Employers should provide periodic refresher training which stresses the hazards that exist within confined spaces to all employees who work in or around confined spaces.

Discussion: Although the victim in this case was a supervisor who had received training in confined space entry procedures, he elected to forego written company safety procedures regarding atmospheric testing and the use of safety harnesses and lifelines. His failure to follow standard written procedures concerning confined space work was an important factor in this incident.

Recommendation #3: Company management (safety) personnel should conduct periodic worksite evaluations to ensure that written procedures are being followed in the field.

Discussion: In this case a foreman apparently chose to ignore company procedures regarding work in confined spaces. Since safety is an inherent function of management, workers cannot be expected to follow safety procedures if their supervisors do not. Periodic inspection of worksites by company safety personnel would serve to show management's interest in the safety program and reinforce within all workers the need to follow company standard operating procedures.

Recommendation #4: An evaluation of the worksite should be performed prior to the start of all operations to determine potential safety and health hazards as well as concerns which would affect efficiency of the operation.

Discussion: An evaluation of the worksite prior to the start of work would permit safety hazards to be identified and plans for corrective action to be prepared prior to employee exposure. In the above case such an evaluation might have enabled the workers to avoid the initial climb up the tower to unlock the door at the top of the tank. In addition, a thoughtful evaluation might have convinced the supervisor to utilize the hatch at the catwalk rather than the opening at the top of the tank. Such action may have eliminated the need for the rope ladder and thus prevented the fall.

Recommendation #5: Rescue personnel entering confined spaces should utilize appropriate protective equipment.

Discussion: In the above case, rescue personnel entered a confined space where a victim became ill and had fallen for unknown reasons without either checking the atmosphere first or utilizing self-contained breathing apparatus. In similar situations rescue personnel themselves often become victims. NIOSH investigations of 41 confined space incidents have revealed that 18 (31%) of the 59 victims were would-be rescuers.

FACE 90-12: Painter Dies When Scaffold Falls Inside Municipal Water Tank in Indiana

INTRODUCTION

The employer, a painting contractor with 20 employees, has been in business for 7 years. The company has a designated safety officer and written safety rules and procedures, but no formal training program. The victim was hired as a journeyman painter, and had worked for the company for 1 month at the time of the incident. The victim had previously been employed as a painter by other contractors for approximately 10 years.

INVESTIGATION

The victim was a member of a three-man crew engaged in painting the interior and exterior of two 68-foot-tall by 32-foot-diameter municipal water tanks. The crew had been working on this project for 2 weeks prior to the incident, and had completed all work on one tank and most of the exterior work on the second.

On the day of the incident, the crew arrived at the worksite at approximately 11:30 a.m. The crew consisted of a foreman, the victim, and a groundman. The foreman was going to spray paint the interior of the water tank while the victim was to finish work on the exterior of the tank. The groundman was to work inside the tank handling the spray paint lines used in the operation. The victim, a journeyman painter, asked to paint the interior of the tank. The foreman agreed, and the victim proceeded to paint the interior of the tank while the foreman finished work on the exterior of the tank.

Access to the interior of the tank was provided through a manhole on the side of the tank at ground level, and a second manhole located on top of the tank. This second manhole was reached by climbing a fixed ladder on the exterior of the tank.

The interior sidewalls of the tank were reached via a swing scaffold rigged inside the tank. This scaffold consisted of an aluminum ladder secured to a steel "stirrup" (a steel bar bent into a box shape and installed perpendicular to the ladder) at each end. The ladder was thus subjected to loading while in a horizontal position, rather than in the vertical position for which it was designed. Cables from each stirrup ran to a common tie-off point. A cable from this common tie-off point then passed through a block and tackle. By pulling on this cable the entire scaffold could be raised and lowered from the ground level of the interior of the tank. The block and tackle which supported the scaffold was secured by a single cable which looped around a vertical steel pipe on top of the tank and fastened back to itself by two "U" bolts.

The entire crew entered the tank through the lower manhole. The groundman and the supervisor then raised the scaffold with the victim on it to the top of the tank. The victim was wearing a safety belt and lanyard which was secured to a lifeline, with the lifeline secured to a steel railing on the top of the tank. The victim proceeded to paint the top few feet of the tank's interior. The foreman climbed the exterior ladder to the manhole on top of the tank to help complete work near the tank's top. At approximately 1 p.m., the victim completed painting at the upper level. He then disconnected his lanyard from his lifeline and moved over to where he could hand the paint spray gun to the foreman so the foreman could finish a small area at the top of the tank. The foreman had just taken the spray gun from the victim when he heard a "pop" and saw the victim and the scaffold on which he was standing, fall to the floor of the tank 65 feet below. The victim and the scaffold struck the floor of the tank, barely missing the groundman. The foreman called to the groundman and told him to go next door and call an ambulance. The foreman then descended the ladder on the exterior of the tank and went in to assist the victim. The Emergency Medical Service (EMS) unit arrived on the scene approximately 5 minutes after the incident, removed the victim from the tank via the lower manhole, and transported him to the local hospital. The victim was pronounced dead at the hospital at 2:29 p.m.

Investigation after the incident revealed that the two "U" bolts on the cable which supported the block and tackle had allowed the cable to slip through them, causing both the scaffold and all of its supporting

hardware to fall. This particular rig had been used daily for 2 weeks preceding the incident with no problems.

CAUSE OF DEATH

The cause of death was listed by the coroner as "hemorrhage from severe liver laceration and brain stem hematoma."

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Appropriate personal protective equipment should be worn at all times whenever the potential for a serious fall exists.

Discussion: In this case the victim was wearing a safety belt and lanyard, however at the moment when the incident occurred he was not hooked up to his lifeline. This failure to use PPE at all times during the job allowed the victim to experience a fatal fall when a scaffold failure occurred.

Recommendation #2: Suspension scaffold rigging should be inspected periodically to ensure that all connections are tight and that no damage to the rigging has occurred since its last use.

Discussion: The scaffold rigging in this case had been used daily for 2 weeks prior to the incident; however, no periodic inspection program was in place. It appears that the "U" bolts holding the scaffold had loosened over time, although this loosening had not been observed by workers at the site.

Recommendation #3: Equipment should only be used for the purpose for which it was designed.

Discussion: The "scaffold platform" in this incident was a simple aluminum ladder. This ladder was designed to support a load in a vertical position but was being utilized to support a load while in a horizontal position. While this did not directly contribute to this incident, the potential for a failure of the ladder while being used in this manner was certainly present.

FACE 90-16: Painter Dies Following a 40-foot Fall from Scaffold Inside Water Tank in Ohio

INTRODUCTION

On November 20, 1989, a 39-year-old male painter (victim) fell 40 feet from a scaffold, when one of the nylon suspension ropes supporting the scaffold broke. Although the incident occurred in Ohio, the victim died in a Pennsylvania hospital. On November 30, 1989, officials from a county coroner's office in Pennsylvania notified the Division of Safety Research (DSR) of the death, and requested technical assistance. On December 12, 1989, a research industrial hygienist from DSR traveled to the incident site to conduct an investigation. The DSR investigator reviewed the incident with company representatives and the OSHA compliance officer assigned to the case, and obtained photographs and diagrams of the incident site.

The employer is an industrial painting contractor who has been in business for 10 years. Most of the employer's business involves painting building exteriors and other outdoor structures. Contracted work is either done by the owner himself or with the help of one or two hired workers, depending on the job. The victim in this incident was the owner's brother, who also owned his own painting company and had been an industrial painter for 15 years. The employer has no safety program.

INVESTIGATION

The employer had been contracted by a manufacturing company to sandblast and paint the interior and exterior of a 250,000-gallon steel water tank, which measures 48 feet high by 30 feet in diameter. The tank has an 18-inch-diameter manway on the side 12 inches from the bottom, and a 3-foot-square hatch on top of the tank near the edge.

The employer hired a laborer to help him with the job. The owner and laborer had sandblasted and painted the outside of the tank 3 weeks prior to the incident, using a two-point suspension scaffold. The scaffold consisted of a platform (20 feet long and 2 feet wide) constructed of angle iron and wood planks with a metal guardrail. The top rail of the guardrail was 40 inches above the platform. The platform was suspended by two, 5/8-inch-diameter nylon ropes from a triangular framework ("stirrup") of angle iron at the ends of the platform. The nylon ropes passed through a block and tackle hoist at both ends of the platform. The other end of each rope was tied to a vent pipe on top of the tank. By pulling and letting up on the individual ropes and tying them to the platform, the scaffold platform could be positioned at the desired height.

After painting the exterior of the tank, the owner hired his brother (the victim) to help him sandblast and paint the interior. In order to remove the moisture and condensation inside the tank, the owner opened the manway and hatch, and positioned two propane salamander heaters equipped with blowers just outside the manway to blow warm air into the tank. The owner, the victim, and the laborer entered the tank through the manway and hatch with the necessary scaffold parts, and set up a suspension scaffold similar to the two-point suspension scaffold used on the outside of the tank. However, with this scaffold, three platforms were joined together by overlapping the ends of two other platforms inside the stirrups at the ends of the center platform. The resulting configuration formed a "U"-shaped, four-point suspension scaffold.

Before the suspension scaffold was raised into position, the victim climbed a ladder to weld steel brackets to the opposite side walls at the top of the tank. The brackets were used to anchor a horizontal 3/8-inch-diameter steel cable (to be used as a fall protection anchor cable). The nylon suspension ropes were lying on the floor of the tank while the brackets were being welded. After the welding, the owner inspected the suspension ropes by passing each rope length through his hands, but did not notice any apparent damage to the ropes.

The four suspension ropes and two, 300-watt portable utility lights were then tied to angle iron roof support beams at the top of the tank. Another 300-watt utility light was secured to the center scaffold platform. The entire scaffold platform was raised to approximately 40 feet above the floor and the victim

began sandblasting the top portion of the tank wall. During the sandblasting, the victim wore a supplied air respirator (without an auxiliary, escape-only SCBA), a sandblaster's hood, gloves, and coveralls. The owner urged the victim to wear a safety belt, secure it to a vertical rope (lifeline) with a rope-grab device, and secure the other end of the lifeline to the horizontal steel cable at the top of the tank. The victim chose not to wear the fall protection equipment, saying that it would get in his way. After the victim had sandblasted as much of the top portion of the tank as he could reach, the platform was lowered to the floor of the tank and the nylon suspension ropes were reattached to roof support beams above the portion of the tank which had yet to be sandblasted. The three men began raising the scaffold platform by alternately raising each suspension point a few feet at a time. Again, the victim did not wear any type of fall protection equipment. The laborer, however, did wear a safety belt/lifeline tied off to the steel cable as the owner had suggested. The owner was standing at the bottom of the tank during this time.

While the victim (who was standing on the platform at one end) was pulling on a suspension rope to raise one end of the scaffold, it broke, causing that end of the platform to fall. The victim fell approximately 40 feet, landing on a horizontal, 2-inch-diameter water pipe at the bottom of the tank. The laborer managed to remain standing on the other platform leg which stayed intact. The owner rushed to the victim (who was unconscious but still breathing), placed the victim on a piece of planking, and the owner and laborer subsequently removed him from the tank through the manway. The laborer then ran to the manufacturing plant for help. The county emergency medical service (EMS) was notified and arrived at the site 12 minutes later. The victim was rushed to a local hospital and then air transported to a larger hospital where he died in the operating room 3 hours later. An OSHA investigation determined that the suspension rope broke at a point where it had been burned.

CAUSE OF DEATH

The coroner listed the cause of death as blunt force trauma to the head and trunk.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Synthetic rope used in suspension scaffolding should be protected from heat producing sources.

Discussion: Paragraph 3.25 of the American National Standards Institute (ANSI) "Safety Requirements for Scaffolding," A10.8-1977, states that "Special precautions shall be taken to protect scaffold members, including any wires, fiber, or synthetic rope when using a heat producing process." Occupational Safety and Health Administration (OSHA) standard 29 CFR 1926.451(a)(18) states that "No welding, burning, riveting, or open flame work shall be performed on any staging suspended by means of fiber or synthetic rope." An OSHA investigation after the incident determined that the rope had broken at a point where it had been burned. Exactly how the rope was burned is not clear. The victim had previously welded steel support brackets to the inside of the tank. Although the welding was not done from the scaffolding platform, it was performed above the nylon rope which was lying on the floor of the tank before the scaffolding was raised. Also, the 300-watt utility lights may have come too close or contacted the nylon suspension ropes sometime during the sandblasting operation.

Recommendation #2: Suspension scaffolding should be constructed and maintained in accordance with OSHA Standard 19 CFR 1926.451, and ANSI Standard A10.8-1977.

Discussion: The OSHA and ANSI Standards require synthetic or fiber rope used for scaffold suspension to be capable of supporting at least six times the rated load (29 CFR 1926.451(a)(19) and (i)(5), and ANSI A10.8-1977, 3.23). Due to the size and type of rope being used it is questionable whether it was capable of meeting this requirement.

Recommendation #3: Where the potential for a fall from an elevation exists, employers should ensure that fall protection equipment is provided and used by workers.

Discussion: Although fall protection equipment, consisting of a steel anchor cable secured horizontally across the top of the tank (to secure lifeline ropes), lifeline ropes, safety belts, and rope-grab devices, was available at the site during the incident, it was not used by the victim. The use of a safety belt/lanyard combination is required by 29 CFR 1926.451(i)(8) for use on two-point suspension scaffolds. The use of the safety belt or body harness/lanyard with a rope-grab device is appropriate for persons working from scaffolds at varying heights. Properly used, this type of fall protection would have prevented the victim from falling even when the scaffolding fell.

Recommendation #4: Employers should develop and implement a safety program designed to help workers recognize, understand, and control hazards.

Discussion: OSHA Standard 1926.21(b)(2) states that "the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." Even small companies should evaluate the tasks performed by workers, identify all potential hazards, then develop and implement a safety program addressing these hazards, and provide worker training in safe work procedures. Prior to starting any job, the employer should conduct a jobsite survey, identify all hazards, and implement appropriate control measures.

Recommendation #5: Employers should develop and implement specific procedures for entry and work in confined spaces.

Discussion: The owner and workers in this incident were working inside a confined space. Even though the victim died from the result of a fall, there were other potential hazards associated with the work to be performed inside the tank (i.e., painting the inside of a tank with a toxic and flammable paint). Although most of the work contracted by the employer does not require confined space entry, it is reasonable to expect that future work might require the employer and hired workers to enter other types of confined spaces. The company should therefore, develop and implement a confined space entry program as outlined in NIOSH publications 80-106, "Working in Confined Spaces," and 87-113, "A Guide to Safety in Confined Spaces." Minimally, the following items should be addressed:

1. Has the air quality in the confined space been tested for safety?

   - Oxygen supply at least 19.5%
   - Flammable range less than 10% of the lower explosive limit
   - Absence of toxic air contaminants

2. Have employees and supervisors been trained in the selection and use of personal protective equipment and clothing?

   - Fall protection
   - Respiratory protection
   - Emergency rescue equipment
   - Protective clothing

3. Have employees been trained for confined space entry?

4. Have employees been trained in confined space rescue procedures?

5. If ventilation equipment is needed, is it available and/or used?

6. Is the air quality tested when the ventilation system is operating?

Recommendation #6: The designers/manufacturers of tanks of this type should design and install appropriate anchor points for maintenance purposes.

Discussion: Permanent structures of this type are known to require extensive maintenance when they are designed. It is essential that designers/owners of these facilities incorporate appropriate anchor points on tanks to which workers can adequately secure scaffolds and lifelines. Omission of designed anchor points causes workers to improvise anchors or not use them at all. This increases the possibility that a scaffold will be erected using improper procedures and components.